

Adjusting to external imbalances within the EMU, the case of Portugal

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The Portuguese economy is in serious trouble: Productivity growth is anemic. Growth is very low. The budget deficit is large. The current account deficit is very large.

Olivier Blanchard (2007)

Abstract

From 1995 to 2010 Portugal has accumulated a negative international asset position of 110 percent of GDP. In a developed and aging economy the number is astonishing and any argument to consider it sustainable must rely on extremely favorable forecasts on growth. Portuguese policy options are reduced in number: no autonomous monetary policy, no currency to devalue, and limited discretion in chang-

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ing fiscal deficits and government debt. To start the necessary deleveraging a remaining possible policy is a budget-neutral change of the tax structure that increases private saving and net exports. An increase in the VAT and a decrease in the employer's social security contribution tax can achieve the desired outcome in the short run if they are complemented with wage moderation. To obtain a substantial improvement in competitiveness and a large decrease in consumption, the changes in the tax rates have to be large. While a precise quantitative assessment is difficult, the initial increase in the effective VAT rate needed to allow the social security tax to decrease by 16 percentage points (pp) is approximately 10 pp. Such a large increase in the effective VAT rate could be obtained by raising most of the reduced VAT rates to the new general VAT rate of 23 percent. The empirical analysis shows that over time the suggested tax swap could generate surpluses and improve the trade balance. A temporary version of the suggested tax-swap has the attractiveness to achieve a sharper increase in the private saving rate maintaining the short run gains in competitiveness. Finally, the temporary version of the fiscal devaluation could be the basis for an automatic stabilizer to external imbalances within a monetary union.

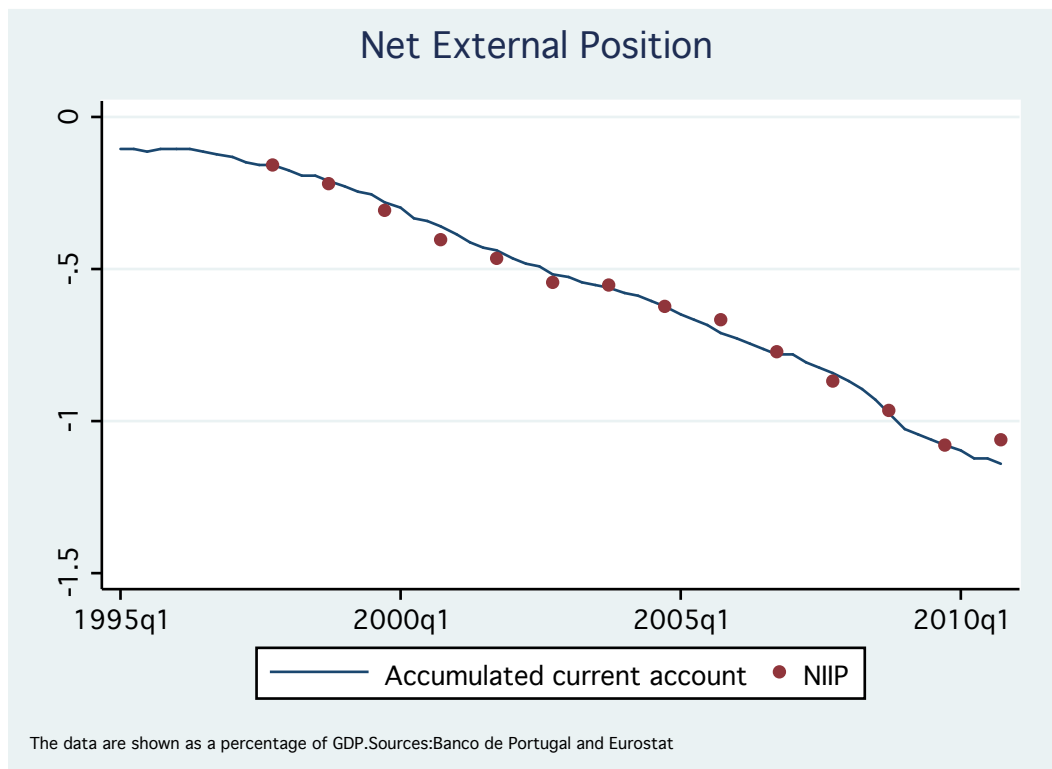


Figure 1: Net International Investment Position

Portugal has been running large current account deficits every year since 1995. These deficits have accumulated to an astonishing 110 percent of GDP negative external asset position.

The sustainability of such a large external position is questionable and must rely on fantastic productivity growth expectations. The recent global financial crisis appears to have anticipated the international investors reality check on those future expectations with the result of a large increase in the cost of external financing. Today the rebalancing of the current account through an increase in national savings and an improvement in competitiveness must be at the top of the Portuguese authorities “to do” list as the cost of a pull out from international investors is of the order of 10% of GDP. The

external rebalancing is difficult as the degrees of freedom of the Portuguese authorities are limited in number: they have no autonomous monetary policy, no currency to devalue, and little discretion in fiscal policy as deficit limits and debt targets are set by the Stability Growth Pact and the post-crisis consensus on medium-term fiscal consolidation. One possibility that remains is to change the fiscal policy mix for a given budget deficit. The purpose of this paper is to explore the effects of a “fiscal devaluation”¹ obtained through a tax swap between employers’ social security contributions and taxes on consumption². The paper begins by illustrating Portugal’s current account evolution during the euro period. The second section lays out a model to offer a qualitative assessment of the dynamic outcomes of the the tax swap. I show that the suggested tax swap can in theory achieve the desired outcomes in terms of competitiveness and consumption if complemented with moderation (stickiness) in wages. I also study the effects of a temporary version of the tax swap and show that it achieves a sharper improvement in the current account that accelerate the rebalancing. The third section moves to the empirical analysis and estimates the likely effects of the tax swap for the Portuguese economy. The fourth section concludes.

¹See Domingo and Cottani (2010) for a recent proposal of fiscal devaluation in Portugal, Greece and Spain.

²Germany employed such a policy in 2007 when they increased VAT by 3 percent and decreased employers’ social security contributions. More recently Hungary has also adopted a similar policy.

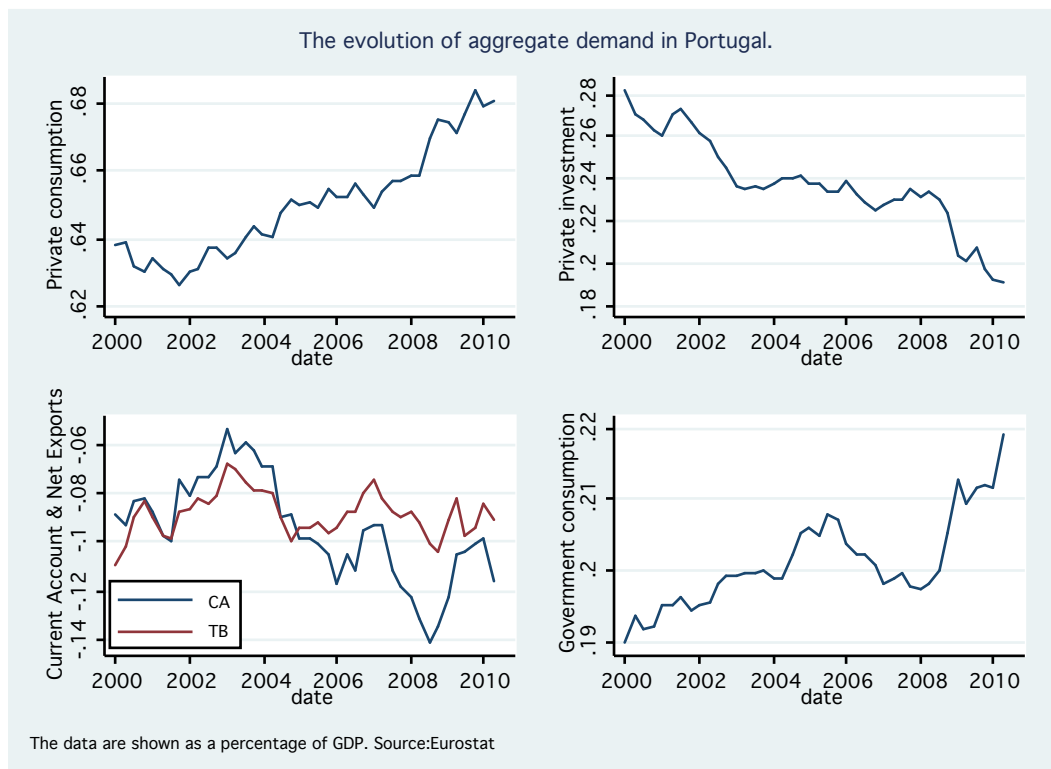


Figure 2: Aggregate demand in Portugal

Portugal in the Euro

Figure 2 shows the evolution of Portugal's aggregate demand since the launch of the Euro.

In words, it shows that private consumption as a share of GDP increased from 63 to 68 percent, private investment decreased from 28 to 19 percent, net exports oscillated around -9 percent and Government consumption went from 19 to 22 percent. The latter declined from 2005-6 but then started to increase again in 2008. The accumulated deficit of the last 15 years is reflected in the large negative net external position³ shown in Figure 1, which, according

³Figure 1 shows the NIIP, which exists at annual frequency, together with the accumulated current account deficits. Until 2009 the two are almost identical. In 2010 a favorable

to the IMF, reached the all time record of 113 percent of GDP in 2009. A lucid and prescient account on the Portuguese economy evolution is given by Blanchard (2007), from which I took the introductory citation, and can be synthesized as follows:

- from 1995 to 2001 (not shown) the participation in the ERM and the buildup of the euro caused a nominal convergence (inflation, interest rates, country risk not decoupling from currency risk) coupled with expectations of real convergence (productivity). The result was an increase in both consumption and investment. The expectations of real convergence justified a benign interpretation of the current account deficit increase.
- from 2001 to 2007 real convergence did not occur and the boom turned into a bust. The current account continued to increase as the real exchange rate appreciated and competitiveness plummeted. The reality check on real convergence expectations shifted the interpretation of the current account deficits from benign to malign but Euro membership shielded Portugal from a refusal to finance additional increases in debt as the spreads with the core euro zone countries were almost nonexistent.

An intuitive reading of Figure 2 suggests that *Portugal must increase private saving* by decreasing consumption *and improve its net exports*. It is worth noting that the statements on saving and net exports are conditional on

change in the prices (capital gains) of assets and liabilities allowed Portugal to maintain the NIIP at 110 percent of GDP even if the current account deficit was close to -10 percent. A lucky year or a very good portfolio management.

the hypothesis that Portugal current external position is not following an equilibrium path. To see this more formally consider the following thought experiment. First describe the process that brought Portugal to its current state with a non identified and unexpected reduced form aggregate shock. Second compute the equilibrium responses of a canonical small-open economy that belongs to a monetary union. For simplicity I assume that the long-run equilibrium (steady state) of the economy has a balanced current account and net foreign asset position but suddenly (shock) finds itself with a negative NIIP of 110 percent of GDP and a current account deficit of 10 percent of GDP.

8

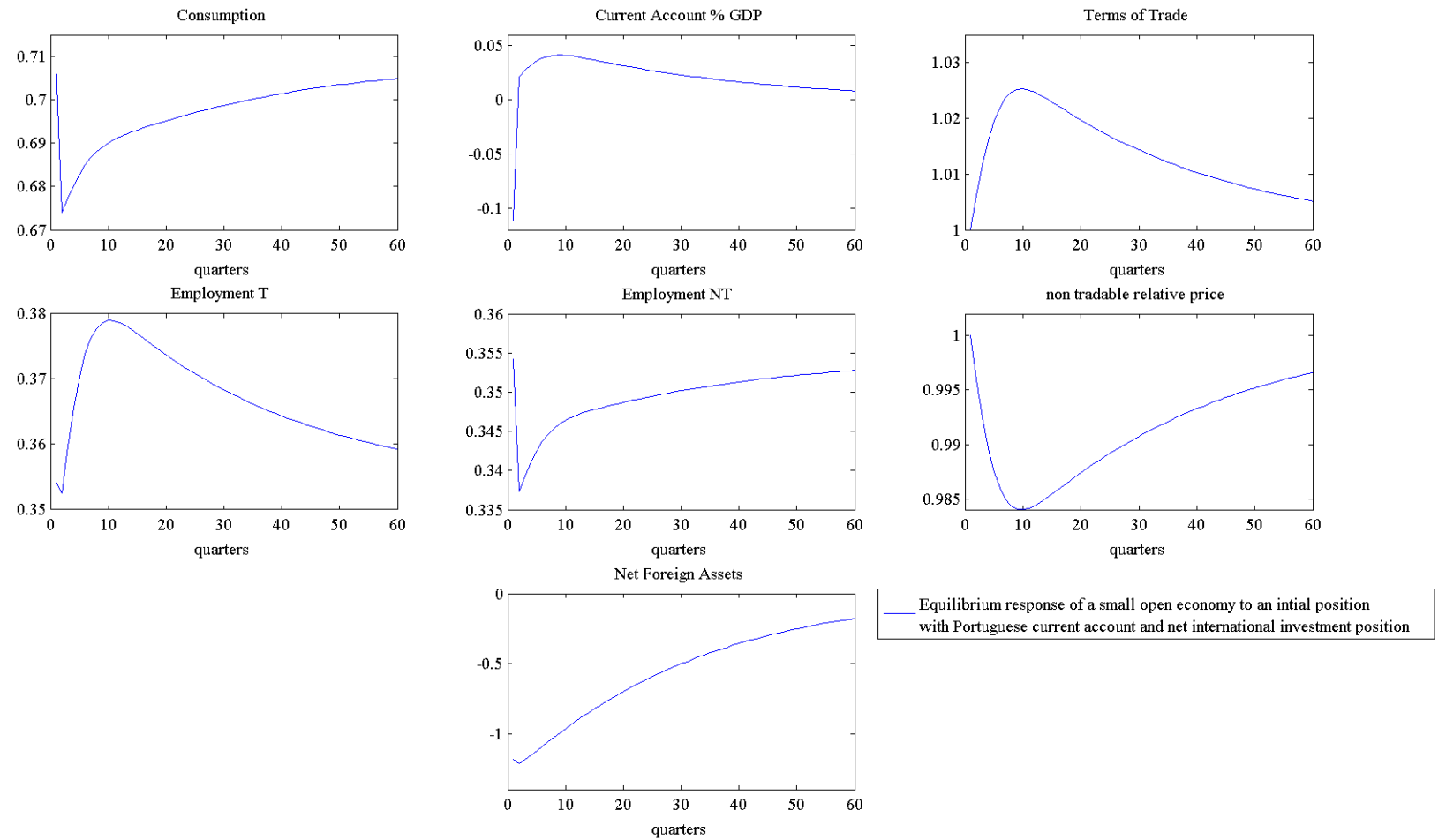


Figure 3: Equilibrium response of a small open economy to the Portugal external position

Figure 3 shows that after such a shock the economy response is to reduce consumption and increase saving. The decrease in demand deflates the economy which in turn increases competitiveness and allow to run a positive trade balance. Net foreign debt is repaid in time with the generated trade balance surpluses. In reality, there was no such shock but a lengthy process, illustrated in Figure 2, that brought the economy to the current position, and in particular this process has been characterized by the absence of the theoretical adjustment (equilibrium responses) illustrated in Figure 3. This last observation suggests that the “self equilibrating” forces in the economy are at best slow in Portugal and that a policy that accelerates or even initiates the required adjustment is necessary. In the pre-EMU era, the natural policy to help the adjustment was to devalue the currency. Today Portugal must find policies that permit a “synthetic” devaluation. In the current limited policy option framework, this could be achieved with a decrease in wages and/or a tax swap from employers’ contributions to social security to VAT. The former solution is politically difficult and possibly unconstitutional in Portugal. The latter can achieve an increase in saving by reducing the attractiveness of consumption and an increase in competitiveness by decreasing labor costs. I now turn to the description of the model underlying Figure 3 and the implementation of a fiscal devaluation within that model.

A framework

The traditional objective of a currency devaluation is to achieve an improvement in external competitiveness to expand exports and reduce imports and,

in this way, stimulate the economy. A fiscal devaluation corresponds to a change in the fiscal structure of a country without its own currency aimed at achieving similar⁴ objectives. Several authors have studied different aspects of the question. The classical paper on the effects of a VAT on competitiveness for a small price-taking neoclassical economy is Feldstein and Krugman (1989). These authors find that “the substitution of value-added taxation for income taxation is likely to have an uncertain short-run effect on a nation’s net exports but is likely to reduce net exports in the longer term”. In their framework, the decrease in the income tax has a substitution effect that favors saving, and therefore the trade balance, in the first period. However when VAT is selective and fall more heavily on traded goods, it will distort demand towards nontradables pulling out resources from the tradable sector and decreasing net exports in the second period. A more recent and closely related study, is a ECB working paper by Lipinska and Von Thadden (2009). These authors use a two-country monetary union DSGE model to study unilateral shifts that direct the tax structure more strongly toward indirect taxes⁵. They find that the effects following such a shift are very small. Implicitly many recent papers that contain open economy models with taxes are related to this work. Most of these works introduce into an economy that is neoclassical in nature in the long-run, some new-Keynesian feature in the short run. The choice of which feature to introduce in the model

⁴The aim of this paper is purely applied, namely to study alternative policy to nominal devaluation to improve Portugal external position. Recently Adino, Correia and Teles (2009) perform the more theoretically oriented exercise to find a set of tax instruments that allow to replicate the allocation achieved by a nominal devaluation.

⁵Their motivation is broad but their first footnote refers to “the substantial increase in German VAT by 3pp in 2007 which was partly offset by reduced contributions to the unemployment insurance scheme”. An exact example of fiscal devaluation.

obviously has important consequences. For example, the cited Lipinska and Von Thadden (2009) which explicitly study the effects of a fiscal devaluation though a tax swap between VAT and labor income taxes use a model with price rigidities but competitive labor markets with flexible wages. Below I show that the flexible nominal wage assumption has important consequence as it neutralizes the demand side effects for the fiscal devaluation. In other words with flexible nominal wage the effects of a fiscal devaluation are purely neoclassical in nature. To organize thoughts I present in the next section a canonical New Keynesian small open economy used to obtain Figure 3. I have left the detailed microfounded description of the economy to an appendix and show a convenient and more intuitive log-linear approximation of the model. Finally I present the model's features in sequential steps to better identify the role of each assumption discuss their plausibility in describing the Portuguese reality.

A benchmark

Households consume and supply labor. Given that the objective is to understand the effects of a fiscal devaluation on competitiveness I start by describing the labor-production side of the economy. In their role of workers, households have some monopoly power (maybe through a union), which allows them to set the wage, w_t , for the labor services they supply, as a mark-up μ_w over their marginal rate of substitution mrs_t ⁶

⁶I present the economy average marginal rate of substitution to keep the exposition simple. Formally (see the Appendix) each worker set its own wage $w(h)$ over its own marginal rate of substitution $mrs(h)$, where h indexes consumers/workers.

$$mrs_t = \frac{1}{\sigma}c_t + \phi n_t + \tau_{c,t} \quad (1)$$

where c_t is consumption, n_t is labour, $\tau_{c,t}$ is the effective consumption tax, σ is the intertemporal elasticity of substitution and ϕ is the labor supply elasticity. Domestic firms produce using only labor and have market power in the goods market which allows them to set the price of the good they produce, p^H , as a mark-up, μ_p , over their marginal cost, mc_t ⁷

$$mc_t = \tau_{w,t} + w_t + \frac{a}{1-a}y_t - \log(1-a) \quad (2)$$

where $\tau_{w,t}$ is the social security contribution tax rate, y_t is output and $a \in [0, 1]$ parametrizes the degree of decreasing returns in labor. These two equations are key to the fiscal devaluation. Consider a decrease in the social security contributions tax rate $\Delta\tau_{w,t} < 0$, where Δ is the first difference operator. Other things equal, the marginal cost of the firm decreases, which allows the firm to lower its price. This is the channel through which the fiscal devaluation improves competitiveness. Second consider an increase in the consumption tax $\Delta\tau_{c,t} > 0$. Other things equal, the marginal rate of substitution increases pushing the worker/union to ask for a higher wage. Combining the two changes in taxes it is immediate to see that if $\Delta\tau_{c,t} = -\Delta\tau_{w,t}$, call it a proportional tax swap, the lower taxes effect on the marginal cost is exactly offset by the increase in the nominal wage, leaving the initial price set by the firm unchanged. In terms of competitiveness, when prices and wages are

⁷I present the economy average marginal cost of substitution to keep the exposition simple. Formally (see the Appendix) each firm sets its own price $p^H(i)$ over its own marginal cost $mc(i)$, where i indexes firms.

flexible, this proportional tax swap is neutral on unit labor costs and only increases the real wage.

Firms are assumed to adjust their prices following a model due to Calvo (1983) characterized by random price durations which leads to a New Keynesian Phillips Curve for domestic price inflation

$$\pi_t^H = \beta E_t \pi_{t+1}^H + \kappa^p mc_t \quad (3)$$

where β is the discount factor and κ^p the elasticity of domestic inflation to the marginal cost. Nominal price rigidity does not alter the neutral outcome of the proportional tax swap: as marginal costs did not change, there is no incentive for firms to change prices so that any impediment to price adjustment is irrelevant. Workers also face Calvo-type constraints on the frequency with which they can adjust wages and this leads to a New Keynesian Phillips Curve for domestic wage inflation

$$\pi_t^W = \beta E_t \pi_{t+1}^W + \kappa^w (mrs_t - w_t) \quad (4)$$

where π_t^W is wage inflation and κ^w the elasticity of domestic wage inflation to the gap between the marginal rate of substitution and the nominal wage. Now wage setters want to ask a higher nominal wage after the increase in $\tau_{c,t}$, but nominal wage rigidity implies that nominal wage will fully reflect the increase in the marginal rate of substitution only after a period of adjustment. During the time when nominal wages adjust to their higher level, the decrease in the social security contribution decreases the marginal cost of the firm and allows firms to decrease prices. In other words nominal price rigidity is

irrelevant while nominal wage rigidity is *necessary* for the proportional tax swap to affect competitiveness.

The intertemporal consumption-saving decision is described by a standard intertemporal condition

$$c_t = E_t c_{t+1} - \sigma (i_t - E_t [\pi_{t+1} + \Delta \tau_{c,t+1}] - \rho) \quad (5)$$

where i_t is the one period run nominal interest rate, π_t is the CPI rate of inflation (net of VAT taxes), and E_t is the mathematical expectation conditional on information at time t . The relevant CPI inflation rate is given by

$$\pi_t = \pi_t^H + \alpha \Delta s_t \quad (6)$$

where $\pi_t^H = p_t^H - p_{t-1}^H$ is the domestic goods inflation, $s_t \equiv \frac{p_t^F}{p_t^H}$ is the terms of trade (ratio of the foreign goods price index over the domestic goods price index) and $\alpha \in [0, 1]$ is the weight of foreign goods in domestic consumption. The international asset market is restricted to a one-period nominal bond with a debt-elastic interest-rate premium on the rest of the union interest rate⁸

$$i_t = i_t^* + \rho(b_t) \quad (7)$$

where i_t^* is the EMU one period nominal interest rate and $\rho(b_t)$ is the domestic risk premium that depends on the level in real terms of the net external

⁸This last assumption is only made for technical reasons. It is well known that the small open economy model with incomplete asset markets features a steady-state that depends on initial conditions and equilibrium dynamics that possess a random walk component. The debt-elastic interest rate assumption is (although realistic for Portugal) is one approach followed in the literature to induce stationarity. In the appendix I discuss an alternative assumption: complete international asset markets.

position b_t . A permanent tax swap does not affect the saving-consumption decision given that $\Delta\tau_{c,t+1} = 0$ in equation 5. However an expected transitory increase in the consumption tax creates an expected negative step in the relevant interest rate $i_t - E_t [\pi_{t+1} + \Delta\tau_{c,t+1}]$ for the household intertemporal decisions, increasing the attractiveness of future (post tax swap reversal) consumption relative to current consumption.

The equilibrium in the goods market requires

$$y_t = \chi s_t + \chi^F s_t + \zeta c_t + \zeta^F c_t^* \quad (8)$$

where c_t^* is the EMU consumption, χ is the elasticity of domestic demand to the terms of trade, χ^F is the elasticity of exports to the terms of trade, ζ is the elasticity of output to domestic demand and ζ^F is the elasticity of output to foreign demand.

Fiscal devaluation as a proportional tax swap

I have described a fiscal devaluation as a proportional tax swap, namely a precise change in the two tax rates such that $\Delta\tau_{c,t} = -\Delta\tau_{w,t}$, and argued that when such a swap is permanent the final outcome of the policy is neutral on allocations and only results in a higher real wage. This neutrality is obviously a particular case but is appealing as it permits to compare the fiscal devaluation to a classical nominal devaluation which is also neutral on allocations in the long run. In other words, in the model above, the proportional tax swap only affects the allocations through demand channels, just like a nominal devaluation. Obviously non-proportional tax swaps would affect the

allocations through well understood neoclassical supply channels, which in the case of the suggested tax swap tend to offset each other. I choose to maintain the proportional tax swap as a benchmark for the fiscal devaluation as demand forces should be more relevant in the short run, the frequency of interest of this work. A nominal devaluation is also usually implemented to reduce unit labour costs relative to foreign competitors, expand exports and reduce imports, i.e. to increase in competitiveness⁹. Both devaluations can only achieve those objectives if the switching-expenditure towards domestic goods is strong enough. In the benchmark model the latter requires the elasticity of substitution between domestic and foreign goods to be large enough. In the model net exports in terms of consumption, nx_t , are

$$nx_t = sh_x ((\lambda - 1) s_t + c_t^*) - sh_m ((1 - \lambda) q_t + c_t) \quad (9)$$

where λ is the elasticity of substitution between foreign and domestic goods, $q_t \equiv \frac{P_t^*}{P_t}$ is the real exchange rate, sh_x is the share of exports in the trade balance and sh_m is the share of imports in the trade balance. To recapitulate the proportional tax swap, when nominal wages are sticky, improves external competitiveness by allowing producers to lower their prices, increases foreign demand and can provoke an expenditure switching towards domestic goods that lowers imports if the elasticity of substitution between foreign and domestic goods is sufficiently large and the increase in domestic

⁹Notice also that, differently from the fiscal devaluation, the nominal devaluation affects real allocations irrespectively if the nominal rigidities are in the price or in the wage. The different assumptions on where the nominal rigidities are change the dynamics of the real wage but in the canonical model presented in the text households own the firms so that distributional effects between wages and profits are irrelevant. Obviously this is an important simplification.

demand is sufficiently low. The last two qualifications might appear restrictive but they are essentially the same restrictions for a nominal devaluation having a positive effect on the trade balance. Finally, an important aspect is the duration of the tax swap. A permanent tax swap, only affects the competitiveness of the economy while a transitory tax swap also distorts the intertemporal choice by favoring saving and achieves a sharper improvement in the current account.

Extending the benchmark

Is the benchmark model adequate to study the first order qualitative effects of the tax swap for the Portuguese economy? I will focus on two departures from the above benchmark. First the assumption that export firms have some degree of monopolistic competition in foreign markets may be unrealistic. Second a large fraction of the economy consists of a non-tradable sector. I will first consider them separately and then combine them.

The small open economy as a price-taker

The classical notion of a small open economy was once associated with price-taking firms in international markets. In this case, χ^F is zero in equation 8 and the domestic economy cannot affect nor the quantity nor the value of exports. If producers have market power in the domestic economy, the decrease in the marginal cost allows to decrease their prices and substitute foreign imported goods with domestically produced goods. Again if the elasticity of substitution is large enough imports will decrease even if total expenditure

increases, which combined with constant exports improves the trade balance which is now given

$$nx_t = sh_x c_t^* - sh_m ((1 - \lambda) q_t + c_t) \quad (10)$$

If producers are also price takers domestically, χ is also zero in equation 8 and the temporary decrease in the marginal cost of production, increases only imports worsening the trade balance. This latter case appears excessively restrictive but highlights the difficulty of a pure price taker small open economy in a monetary union: the only channel left to improve the trade balance is to reduce consumption or an increase in foreign consumption.

Nontradable sector

The presence of a nontradable sector in the benchmark model also makes it more difficult for the suggested tax-swap to improve the trade balance. The details of how the nontradable sector is added to the benchmark model are important. For example the degree of labor mobility across the two sectors will matter for the pace of the short run adjustment. Here for simplicity I assume there is perfect mobility, but this assumption is not innocuous. Generally, with a nontradable sector, part of the deflationary forces unleashed by the fiscal devaluation end up in favoring the domestic demand of nontradables relative to the demand of tradables. The labor costs decrease for firms in both sectors pushes price setters to decrease their price. However because of the price of imports does not change, the relative price of nontradables in terms of tradables decreases, pushing consumers to switch expenditure both

from home produced and foreign produced tradables towards nontradables. In this case, all other things equal, the elasticity of substitution between domestic and foreign tradable goods must be higher than in the benchmark case for the trade balance to improve. The trade balance is now

$$nx_t = sh_x((\lambda - 1)s_t + c_t^*) - sh_m((1 - \lambda)q_t + (\lambda - \xi)p_t^T + c_t) \quad (11)$$

where ξ is the elasticity of substitution between tradables and non tradables and p_t^T is an index price for tradables relative to the CPI.

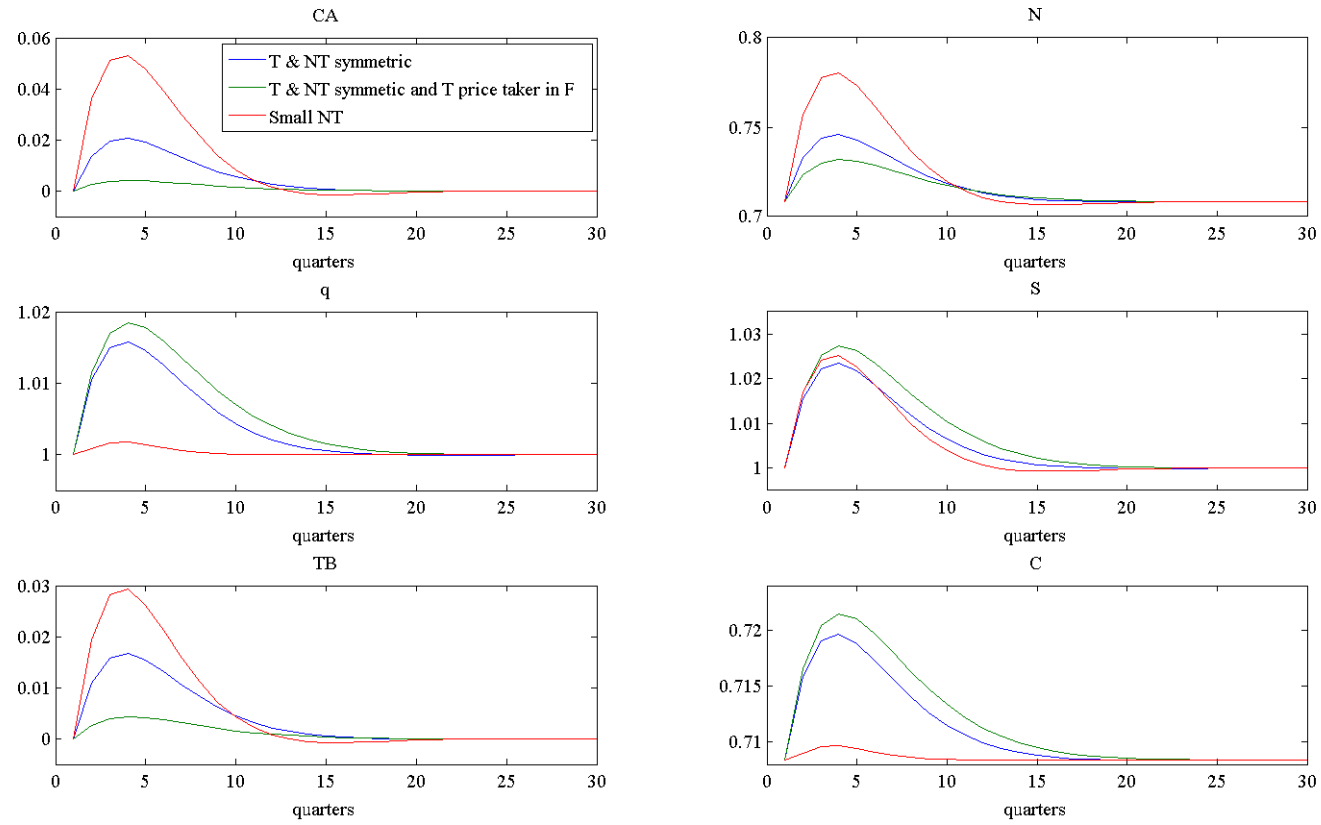


Figure 4: Barriers to the fiscal devaluation: 1. price taker, 2. non tradable sector.

Figure 4 shows the response to a proportional tax swap in three different cases¹⁰. In the first case the tradable and nontradable sectors have the same size (symmetric), in the second case the two sectors have the same size but the tradable sector is a price taker on foreign markets and in the third case the non tradable sector is small relative to the tradable. The latter case corresponds to the benchmark while the other two show how the fiscal devaluation has a lower effect on the trade balance when the nontradable is large and/or the tradable is a price taker on foreign markets.

Implications

In light of Figure 4, the degree of market power on foreign markets and the size of the non tradable sector are most important to evaluate the efficacy of the fiscal devaluation. Is Portugal a price taker on foreign markets? On one hand the very small size of the Portuguese economy would suggest an affirmative answer, on the other hand the degree of specialization in production in advanced economies is such that most production units might have some degree of market power. In practical terms the critical question is if Portuguese exporters will decrease their prices in face of a decrease in unit costs of production. The size of the nontradable sector is also difficult to measure. The old dichotomy between manufacturing (tradables) and services (nontradables) is not anymore relevant¹¹ and the identification of non

¹⁰The model is calibrated using standard values for all parameters: calibrated parameters for the Portuguese economy have very similar values to those of other economies which is somewhat surprising (not to say disturbing). In the appendix I report a table with the value of the parameters.

¹¹In the case of Portugal the trade balance in services is positive largely because of travel (tourism).

tradables has shifted towards national network industries such as the distribution sector, i.e. retail/wholesale trade. However every sector is likely to have an output with some tradables and non tradables elements. One criteria adopted in the literature (see Bems (2008)) is to define the nature of the output of relevant sectors according to its tradability relative to the retail/wholesale trade sector, where tradability is measured as the sum of a sector's exports and imports over the gross output. A sufficiently precise identification of the tradable and nontradable sectors could permit to implement a targeted fiscal devaluation by lowering the social security contribution only to tradables industries shutting down the dilution of the deflationary forces by the non tradable industries¹². However such an identification is difficult, for example according to the previous criteria the “Real estate and business services sector” is a tradable sector in Portugal. Finally while the differentiation between tradables and non tradables might be important for the success of the fiscal devaluation on competitiveness, such a policy would not be anymore neutral on the supply of the economy as it distorts allocations towards tradables. The latter distortion might be desirable but it belongs to the long-run-supply side policies while the proportional tax swap suggested belongs to the short-run-demand side policies¹³.

¹²A cruder and somewhat heterodox alternative would be to control prices in the non-tradable sector

¹³Obviously the two class of policies are complementary but again the focus of this work regards the latter.

A transitory tax swap

As I mentioned above, a transitory tax swap also affects the relative price of future consumption (the relevant real interest rate). This additional channel is decoupled from competitiveness considerations but can achieve a much stronger improvement of the current account by increasing the household incentives to save. The saving channel might result important in light of the implications of the presence of large nontradable sector and absence of market power in foreign markets for the competitiveness channel. Figure 5 shows the theoretical adjustment paths after an initial “Portuguese shock” in the case of no-policy and in the case of a permanent and a transitory (8 quarters) proportional tax swap.

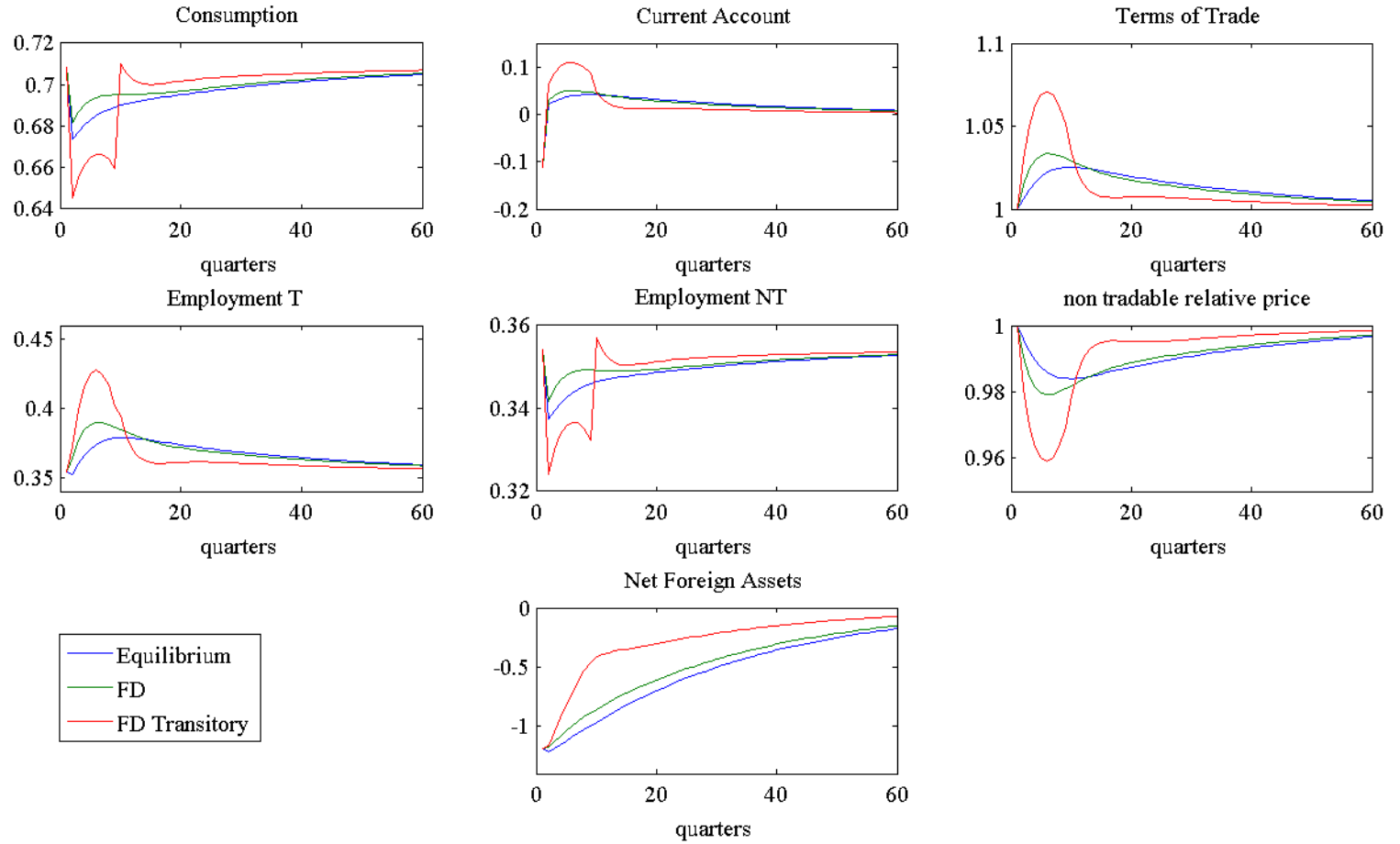


Figure 5: Equilibrium adjustment path with and without a fiscal devaluation $\Delta\tau_c = -\Delta\tau_w = 0.1$.

The Government budget

In the model I have abstracted from government budget considerations¹⁴ as tax revenues are rebated to the households in a lump sum manner. In order for the shift from labor taxes to consumption taxes to be revenue-neutral I could introduce government debt dynamics, endogenize one of the tax rates, say τ_c , and impose a fiscal rule that maintains the budget balanced as in Lipinska and Von Thadden (2009). While the neutrality on the budget is practically desirable, in the model it would cause allocationals effects as the tax rates would not move proportionally. Again the focus of the theory section is to isolate the short run effects of the fiscal devaluation¹⁵. To have a sense of the empirical magnitudes involved in the effective tax rates swap, both on the external balance and on the government budget, I depart from the precise but necessarily over simplistic model presented above and turn to a more reduced form empirical analysis.

Portugal data

Portugal tax revenue

A desirable aspect for the suggested policy would be to maintain as much as possible the tax revenue unchanged. In Portugal the general VAT tax rate is 21 percent and will soon be increased to 23 percent and the employer's social

¹⁴The model is too stylized to provide reliable indications on the revenue dimension. One reason is that, because I have abstracted from other factors such as capital, the labor income share in the model is too large.

¹⁵In a richer environment, the budget deficit or the budget surplus created by the proportional tax swap add a more traditional fiscal policy element to the demand-side dimension to the suggested fiscal devaluation.

Table 1: VAT and ESSC in Portugal, year 2007

	Tax Basis	Tax rate	Revenue	Effective tax rate
Consumption	65%	21%	8.79%	10.81%
Gross Wages s.t. Tax	40.4%	23.7%	8.68%	21%

security contribution tax rate is 23.75 percent of the gross wage. These two taxes generate a revenue of approximately 8.6 percent of GDP each. Table 1 shows the tax basis, tax rates, and effective tax rate, defined below, for 2007.¹⁶

A simple back-of-the-envelope calculation, keeping the tax basis fixed, indicates that for each percentage point increase in the effective VAT rate, the Government can decrease the ESSC rate by 1.6 pp and keep the revenue unchanged. Equivalently a 2.47 pp of effective ESSC or a 1.53 pp of effective VAT generate 1 pp of GDP of tax revenues. Of course the basis will change after the tax swap and I have shown their qualitative path in the model simulations. To quantify the effects of the proportional tax swap on the tax basis and the trade balance, I estimate two Structural Vector Autoregression to find the elasticities of private consumption and of the wage bill (the two tax basis), and of exports and import (the trade balance), to a shock to the

¹⁶The numbers are slightly different from those presented in a preliminary version of the paper. For what regards VAT, I consider only revenue generated by private consumption. Pereira and Rodrigues calculate that for the period 1990-1998, VAT revenue generated by private consumption was 11.4 percent of GDP, VAT revenue generated by private Investment was 1.84 percent of GDP and VAT revenue generated by public expenditure was 0.94 percent of GDP. I assume the proportion did not change so that private consumption corresponds to 80 percent of the VAT tax basis. For what regards the social security, in the previous version of the paper I was assuming that the effective tax rate was equal to the marginal tax rate and calculated the tax basis from revenues. In this version, to keep comparability with the effective VAT rate, I compute the basis as Total compensation minus social security contributions paid by the employers and use it to calculate the effective tax rate.

effective VAT rate, τ_c in the model above, and to a shock to the effective social security tax rate, τ_w in the model above. I estimate two distinct statistical models, one for each tax rate shock, because Portuguese quarterly data only exist since 1995 so that the number of observations is relatively small and does not allow to estimate large models.

A shock to τ_c

Empirically the effective tax rate on consumption is defined as

$$\tau_c \equiv \frac{VAT}{PC} = \frac{\sum_{s=1}^{n_c} \tau_s p_{c_s} c_s + \sum_{s=1}^{n_i} \tau_s p_{i_s} i_s + \sum_{s=1}^{n_g} \tau_s p_{g_s} g_s}{PC} \quad (12)$$

where n_j is the number categories in each type of expenditure $j = c, i, g$ (consumption, investment and government expenditure, see footnote 14), subject to possibly different tax rates and p_j is the price index of each category. A change in any of the terms of 12 leads to a change in τ_c . I define *a shock to the effective rate any shock that changes τ_c but does not change contemporaneously the nominal expenditures in consumption, investment and government consumption (and imports)*¹⁷. There are potential issues in the suggested identification procedure. First I am not identifying the anticipated component of the tax rate change but only the unexpected part of the shock. Second total nominal expenditure in each aggregate demand component is different from the nominal expenditure subject to taxation: about two-third of consumption and only a small fraction of private investment and govern-

¹⁷Expenditures in consumption are net of VAT. The identification is imposed using a standard recursive specification where none of the other variables react contemporaneously to the tax rate shock.

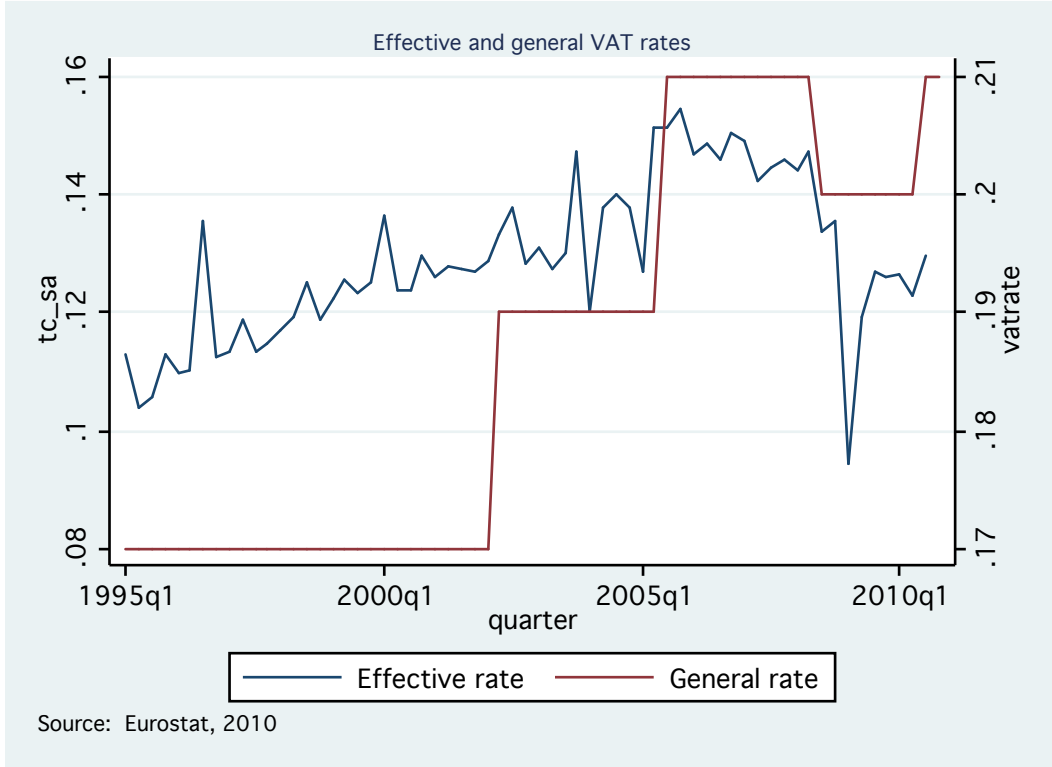


Figure 6: Effective and general VAT rates in Portugal. Source: Eurostat

ment expenditure are subject to VAT. Equation 12 also shows that to change the effective rate the government can change the tax rates τ_s and/or change the basis, n_j ¹⁸. Figure 6 shows the seasonally adjusted effective VAT rate together with the general rate.

The figure shows that when the general rate changes, the effective rates changes in the same direction. However the effective rate exhibits a much more volatile pattern characterized by a few large spikes. Some of the largest spikes can be explained by a change in VAT legislation that did not alter the

¹⁸Define the difference between nominal expenditure and the actual expenditure subject to the VAT as ϵ_j . For example in the case of consumption $\epsilon_c \equiv \sum_{s=1}^{n_c} p_{c_s} c_s - PC$. Therefore the shock the effective rate will contain both changes in the different τ_s and changes in the ϵ_j .

Table 2: VAT history in Portugal

	General	Intermediate	Reduced	Effective tax rate
01.01.1995 – 30.06.1996	17%	-	5%	10.9%
01.07.1996 – 04.06.2002	17%	12%	5%	12.3%
05.06.2002 – 30.06.2005	19%	12%	5%	13.45%
01.07.2005 – 30.06.2008	21%	12%	5%	14.7%
01.07.2008 – 30.06.2010	20%	12%	5%	12.3%
01.07.2010 - 31.12.2010	21%	13%	6%	12.9%

general rate. For example Table 2 shows that the first large spike is in 1996q3 corresponds to the year in which an intermediate VAT rate of 12 percent was introduced.

The previous discussion suggests that a careful narrative approach to the VAT legislation in Portugal could be followed to construct a time series for the effective VAT shock. Here I rely on the identification scheme suggested above. For robustness, I estimate two SVAR, VAR 1 and VAR 2, containing, real imports, nominal private investment, nominal government consumption, nominal private consumption and the empirically measured effective tax rate (VAR 1), or the actual general VAT rate (VAR 2). All variables except the tax are in annual growth rates. The sample is 1996q3-2010q3, the VARs are estimated with two lags and a dummy for the global financial crisis period. Figure 7 shows both the impulse and the cumulated responses of consumption and imports to a one standard deviation of the identified VAT shocks together with 68% confidence intervals for VAR 1.

The two shocks identified with the two alternative measures of VAT tax rate exhibit the same qualitative effect on consumption and imports: a pos-

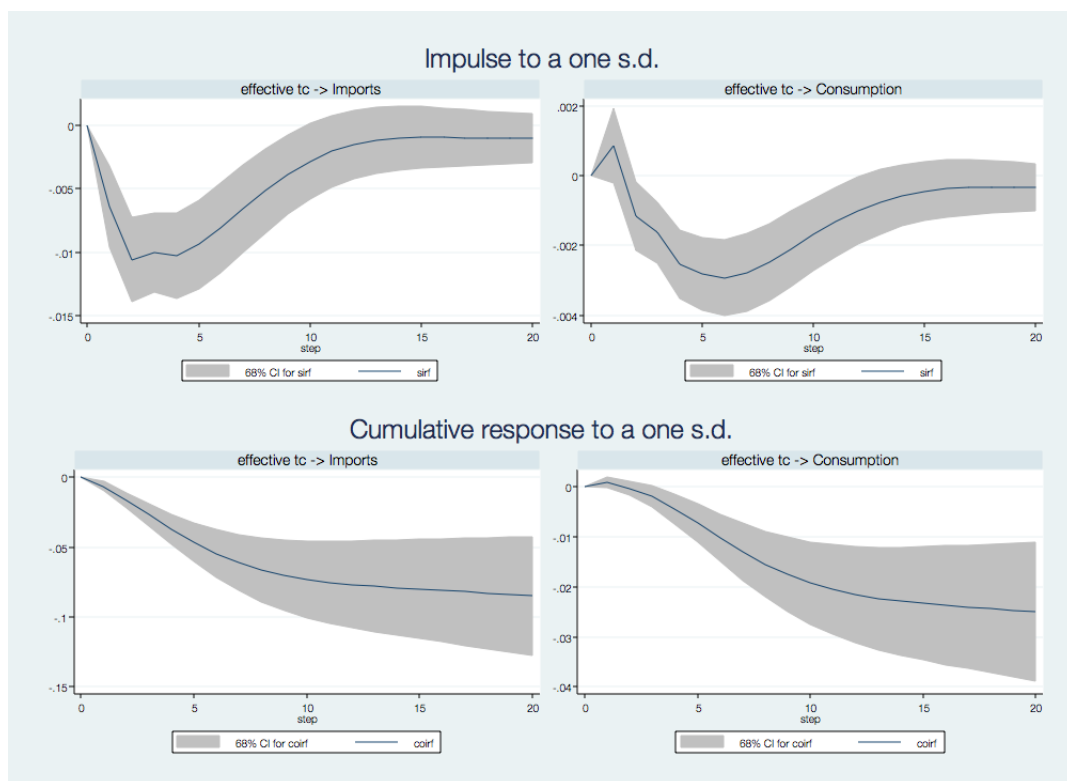


Figure 7: The effect of a shock to the effective VAT rate on consumption and imports.

Table 3: Percentage response to a one standard deviation increase in τ_c , CI 68%

Horizon	τ_c on pc	τ_c on m
2 years	[-1.35,-2.1,-2.8]	[-3.5,-6.27,-8.99]
5 years	[-1.7,-3.4,-5.09]	[-2.9,-8,-13.24]

itive shock, consistently with the benchmark model, decreases persistently both consumption and imports. The results of VAR 2 are less precise therefore in the rest of the paper I use the results of VAR 1. The cumulative responses show that a one standard deviation shock in effective VAT rate decreases the level of nominal consumption (the VAT approximate basis) by 2 percent after 2 years and by 3.2 percent after 5 years. The same shock appears to have an even stronger effect on the real level of imports: 6 percent after 2 years and 8 percent after 5 years. These elasticities appear to be very large. Notice that the uncertainty on the effect is also large and that the standard deviation of the shock is not identified. The lack of identification of the structural shock standard deviation is common to the SVAR literature and does not allow to rescale the elasticities in terms of more practical percentage change in the shock. Table 3 summarizes the results.

A shocks to τ_w

Evidence on the effects of a change in τ_w is somewhat harder to identify as I can only rely on the effective tax rate as there are no a time a series for a

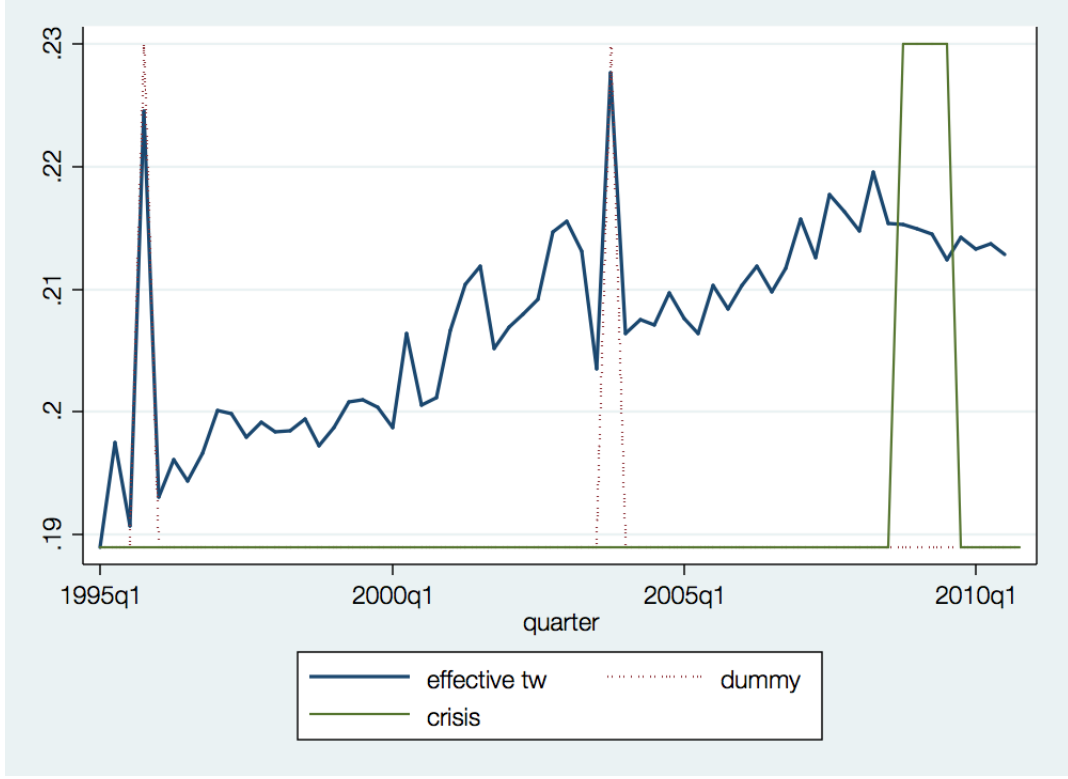


Figure 8: Effective SSC rate in Portugal. Source: Eurostat

the social security general rate¹⁹. Figure shows the effective tax rate defined as follows

$$\tau_w \equiv \frac{SSC}{Compensation - SSC} = \frac{\sum_{s=1}^{n_w} \tau_{w_s} W_s}{W} \quad (13)$$

where SSC are the social security contributions paid by the employers and $Compensation$ is the total compensation paid by the employers inclusive of social security contributions. The effective τ_w exhibits an increasing trend and two evident spikes. The trend corresponds to the widening of the social security during the sample. The two spikes are due to above average revenues in social security contributions during in the fourth quarter of 1995

¹⁹In practice until very recently, the social security contribution legislation was composed of a very large number of different laws which makes it difficult construct such a time series.

and the fourth quarter of 2003. Again, following a narrative approach, these two increases could be explained by new legislation passed at that time such a more punitive stance towards evasion and the creation of a “revenue minimum d’insertion”. I nevertheless decide to control for the two spikes with a dummy but results are not significantly affected by this choice. *I define a shock to the effective rate any shock that changes τ_w but does not change contemporaneously the nominal wage bill W .* The identification assumption is subject to similar caveats than those expressed for the VAT shock. The estimated VAR contains real exports, the nominal wage bill and the effective social security tax rate. Again all variables except the tax are in annual growth rates. The sample is again 1996q3-2010q3, the VAR is estimated with two lags, the dummy for the two spikes of 1995q4 and 2003q4 and a dummy for the global financial crisis period. Figure 9 shows both the impulse and the cumulated responses of the nominal wage bill and exports to a one standard deviation of the identified τ_w shock together with 68% confidence intervals.

A positive shock decreases persistently both the wage bill and exports. The cumulative responses show that a one standard deviation shock in effective social security tax rate decrease the level of the nominal wage bill (maybe through lower employment) by 3 percent after 2 years and by 4.5 percent after 5 years. The same shock decreases the real level of exports by 2.3 percent after 2 years and 2.79 percent after 5 years. Again the confidence intervals are large and the standard deviation of the shock is left unidentified. Table 4 summarizes the results.

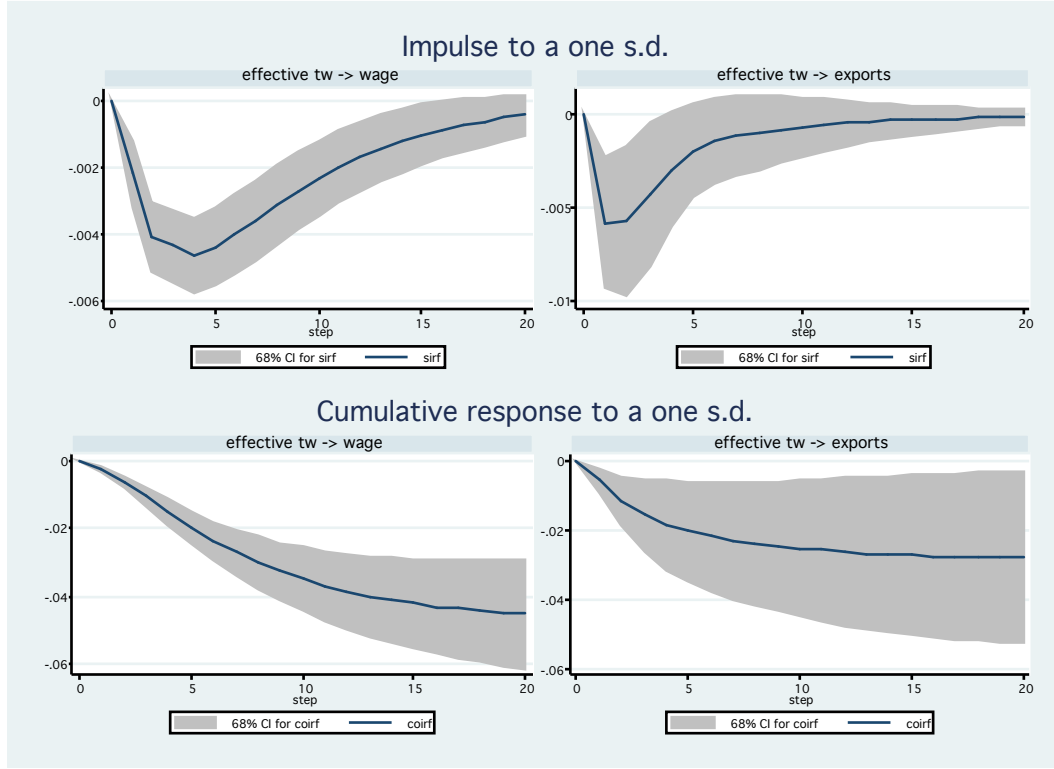


Figure 9: The effect of a shock to the effective social security rate on wages and exports.

Table 4: Percentage response to a standard deviation shock in τ_w , CI 68%

Horizon	τ_w on γ_x	τ_w on γ_w
2 years	[-0.6,-2.38,-4.17]	[-2.52,-3.01,-3.77]
5 years	[-0.30,-2.79,-5.28]	[-2.92,-4.53,-6.14]

Discussion

I mentioned above that a better empirical model would estimate and identify the two shocks in a single statistical model. Typically the omission of relevant information tends to bias estimates, and this is a serious concern for what regards the magnitude of the estimated elasticities. Unfortunately, leaving aside complications on the identification procedure, the number of observations, 59 data points, is too small to obtain meaningful results from the larger model. I also mentioned that the size of the identified shock is left unidentified which does not allow to quantify the effect of a 1 percent increase in the effective VAT rate on consumption and exports but only the effect of a standard deviation increase. A narrative approach to the construction of the shocks would be useful to measure their size. Here I have to take a stand on the relative size of the two shocks to be able to continue meaningfully the analysis. Figure 10 shows the first difference of the two empirically measures effective rate. Their change (and their standard deviations) have similar magnitude. I do not have a better metric than Figure 10 , therefore I choose to assume that the two structural shocks have the same standard deviation.

The empirical effects of the fiscal devaluation

Consider a 1 pp increase in τ_c . According to the simple back of the envelope calculation to keep the tax revenue unchanged on impact τ_w can decrease by 1.6 pp. Accordingly with the assumption that the two structural shocks have the same size, Figure 11 shows the effects of two fiscal devaluations:

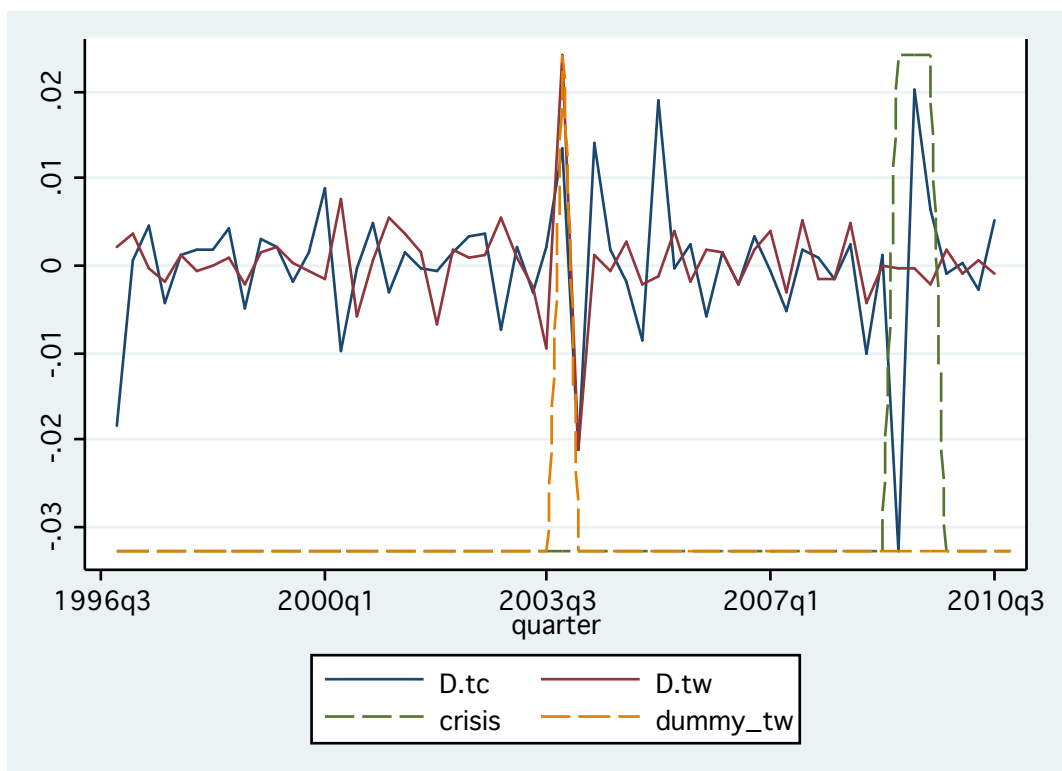


Figure 10: First difference of τ_c and τ_w .

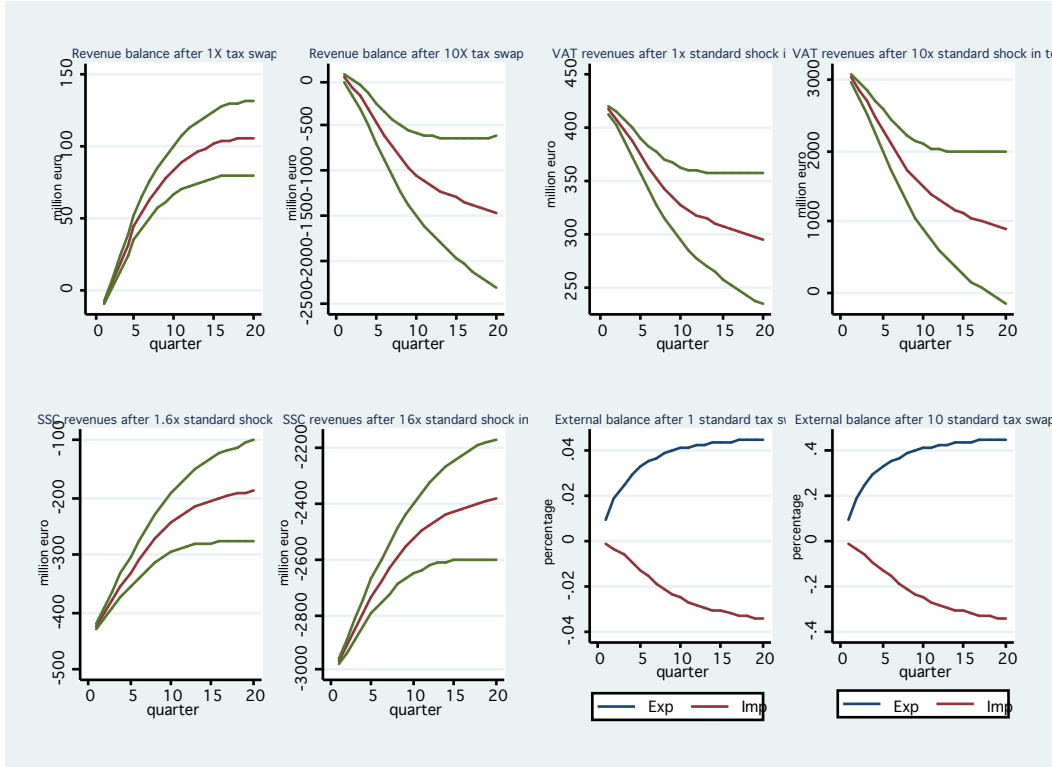


Figure 11: The empirical effects of a fiscal devaluation on tax revenues and the external balance.

the first consider the increase in 1 standard deviation of the effective VAT shock coupled with a decrease of 1.6 standard deviation in the effective social security tax shock, the second a 10 standard deviation increase in the VAT shock coupled with a 16 standard deviation decrease in the social security tax shock.

The estimated effect of τ_w on its own basis (wage) is relatively larger than the effect of τ_c on its own basis (consumption), therefore Figure 11 shows that a fiscal devaluation that would maintain the tax revenue balanced maintaining the tax basis unchanged, has a positive effect on the budget over time and improves substantially the trade balance. For what concerns

the trade balance each standard deviation of the VAT shock decreases real imports by 3.4 percent so that a 10 standard deviation increase is estimated to decrease the level of imports by 34 percent. Further each 1.6 standard deviation decrease in the SSC shock improves the level of real exports by 4.4 percent so that a 16 standard deviation decrease would increase exports by 44 percent. Overall the empirical analysis appears to support both the efficacy and the feasibility of a fiscal devaluation. Finally, to depart from the quantification in terms of standard deviations I further assume that the standard deviation of the two structural shocks is 1 pp (which corresponds to effective rate standard deviation, but this is a poor justification) and consider a decrease of the ESSC from 23.75 percent to 7.75 percent. In theory this would achieve an instantaneous decrease of the labor costs of 16%. Tax revenues would fall on impact by almost 7 percent of GDP. To keep the revenue unchanged, the effective VAT rate should increase by 10 pp. This increase in the effective rate is massive, but so too is the reduction in the cost of labor. Table 2 suggests that the effective VAT rate could be increased from 11.4 percent to 21.4 percent by using the new general VAT rate on almost every good. Considering the recent increase of the general rate from 21 to 23 percent, an almost uniform application of the latter rate could increase the effective VAT rate by the order of magnitude required. The estimated tax basis elasticities suggest that over time the revenue generated by the two taxes will not deteriorate but actually improve. It is important to understand that these numbers are conditional on the size of the shocks so that in practice the uncertainty on the estimates of the relevant elasticities involved in the tax swap requires a frequent monitoring of the tax revenues and its effects

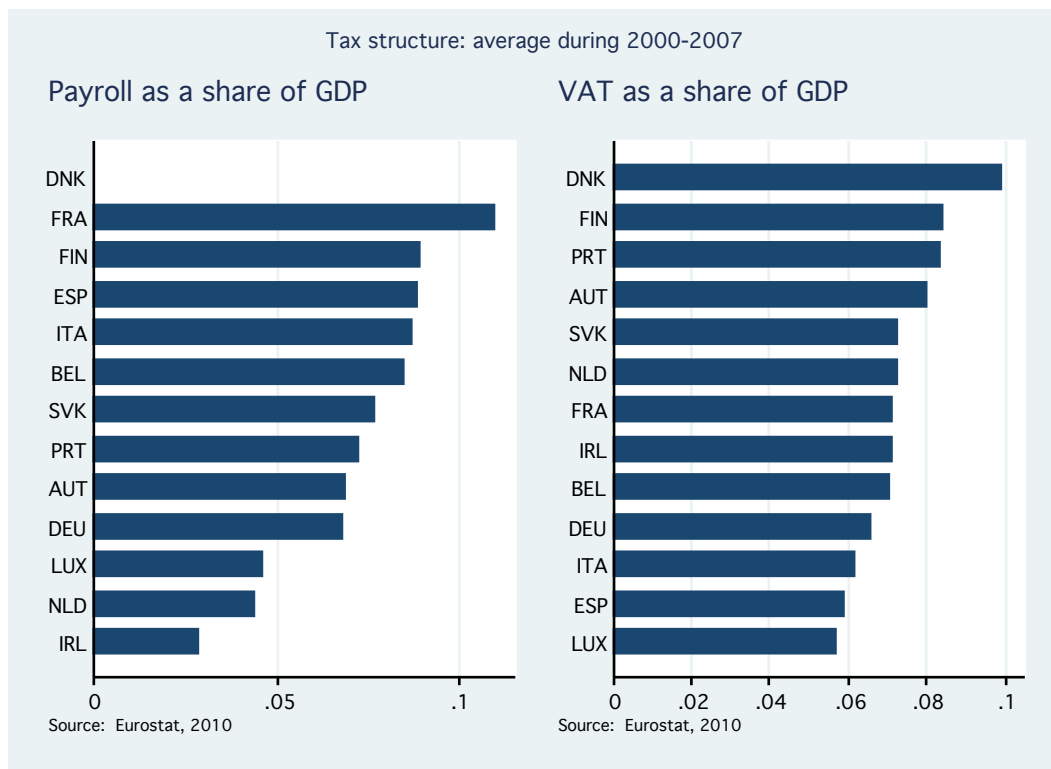


Figure 12: Tax revenues as a share of total tax revenues for VAT and payroll tax collection. The numbers shows are average shares from 2000 to 2007.

on the trade balance. Undoubtedly a permanent tax swap, as opposed to a transitory one, would transform the tax structure of Portugal pushing it far from the average European model, and make it similar regarding VAT and ESSC to Denmark, where payroll taxes are around 3 percent and there is a single VAT rate of 25 percent on virtually all goods and services²⁰.

To illustrate this point, Figure 12 shows that Portugal's reliance on payroll tax for generating tax revenue is just above the European average while VAT appears to be more important than for the rest of the European countries for

²⁰Some goods and services are exempt from VAT. These include newspapers, real estate, the health sector and banking services. These companies pay a payroll tax instead, which is a tax paid on the total payroll. The payroll tax is 3.08% - 9.13% and charged on the actual payroll or, in certain cases, on the result before interest and capital gains.

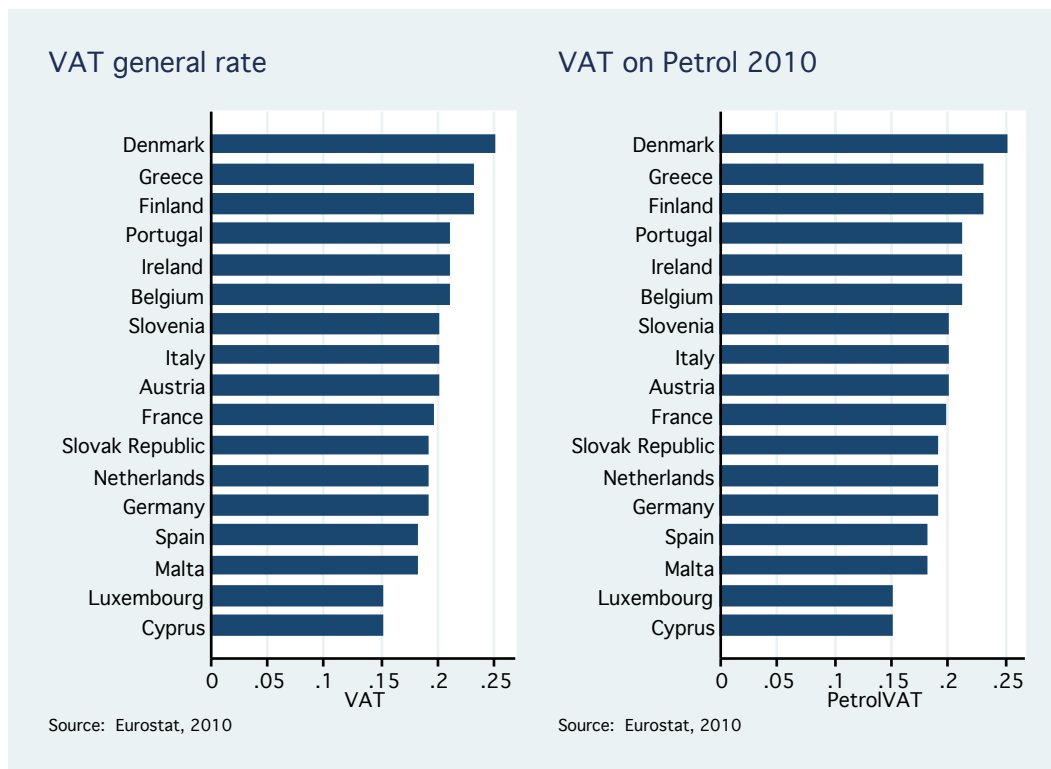
generating tax revenues. The latter observation can only partly be explained by a high general VAT in Portugal relative to the other countries: first, Portugal does not have the highest VAT rate, and second, several reduced VAT rates on relevant goods and services appear to be below other European rate. For example, Figure 13 shows the rates on electricity and natural gas, which appear to be much lower than in the rest of Europe.

In fact, I interpret part of the high dependence of Portugal on VAT revenues as another symptom of excessive Portuguese consumption. Again the departure from a “European model” would not happen in the transitory version of the policy.

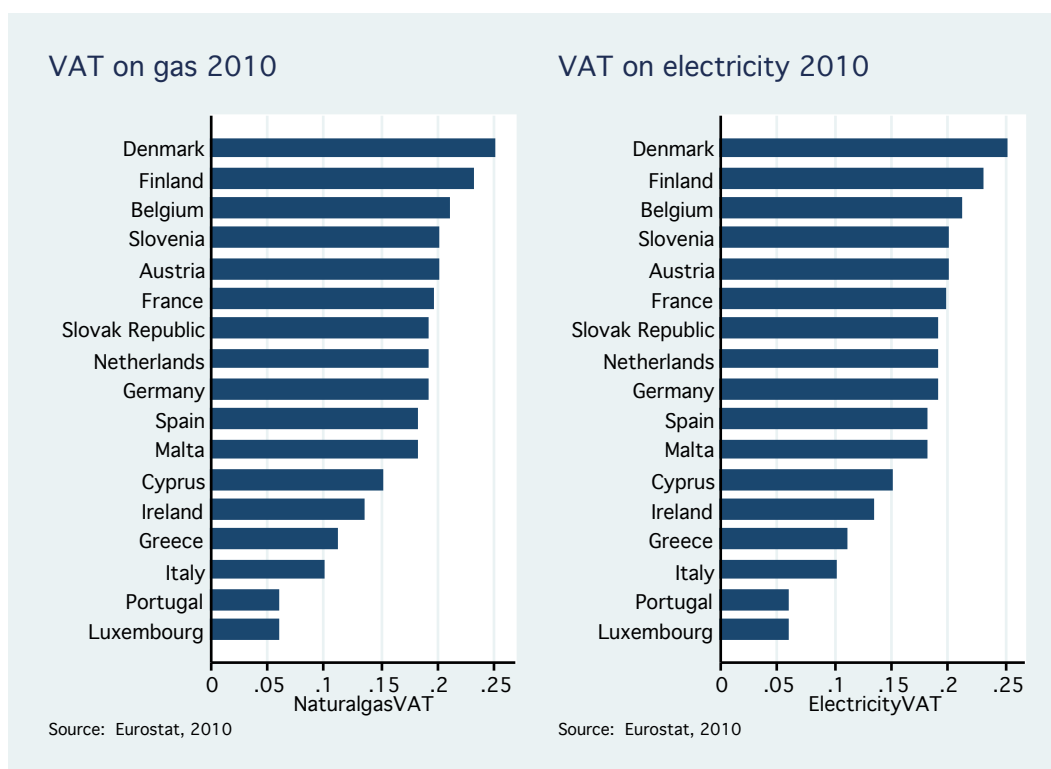
Conclusion

In this work I study the short run effects of a swap between a consumption tax and a labor tax within a monetary union and perform an empirical analysis of the tax swap on Portuguese data. The suggested tax swap is one of the few policy left to individual EMU members to engineer a synthetic devaluation. A transitory version of the tax swap has some attractiveness. A temporary uniformization of the different VAT rates²¹ to the general rate, say for two to four years, could generate the revenues to finance the initial cut in the ESSC rate and allow the dynamic adjustment of lower consumption, higher competitiveness, and higher employment to take place. If the policy is successful, the larger ESSC tax basis would help to compensate the reduction in consumption and probably allow again reducing the VAT rates on particular

²¹I did not discuss redistributive aspects of the tax swap which are obviously important.



(a) VAT rates in Europe, general rate and petrol.



(b) VAT rates in Europe, electricity and natural gas.

goods and services. Most importantly, the sharper reduction in consumption would allow the Portuguese economy to start the much needed deleveraging. On a broader note, I see the sophisticated use of the tax structure by individual EMU members as a possible substitute for more conventional automatic stabilizers to external imbalances. The creation of fiscal tax rules in the spirit of the “budget neutral” temporary tax swap described here could facilitate and accelerate external adjustments with the eurozone as the prospects of a deeper fiscal integration appear remote. Certainly the construction of these new automatic stabilizers requires a great research effort in order to have a more precise comprehension of their effectiveness and feasibility.

Appendix A

Model

Assume an economy with two countries in a monetary union, home (H) and foreign (F). The home country is of size n , while the foreign country is of size $1 - n$. The small open economy version of the model is obtained by taking the limit $n \rightarrow 0$ after having solved the model. Technology and preferences are the same across countries. In the following I describe the home economy while the foreign which is completely symmetric is omitted. All foreign variables are denoted with an asterisk. The next two subsections describe the firms and households problems together with the intratemporal optimality conditions. The third subsection presents the intertemporal optimality conditions for both firms and households. The fourth subsection presents the

market clearing conditions.

Firms

The economy is composed of two two sectors, a tradable sector denoted by T and a non tradable sector denoted by N . Workers are perfectly mobile across sectors. Assume a continuum of firms indexed by $i \in [0, 1]$, each of which produces a differentiated good with the following technology

$$Y_t^x(i) = A_t N_t^x(i)^{1-a}, x = N, T \quad (14)$$

where $Y_t^x(i)$ denotes the output of good i , A_t is an exogenous technology parameter, and $N_t^x(i)$ is an index of labor input used by firm i and defined by

$$N_t^x(i) = \left[\int_0^1 N_t^x(i, h)^{\frac{\sigma_w-1}{\sigma_w}} dh \right]^{\frac{\sigma_w}{\sigma_w-1}}, x = N, T \quad (15)$$

where $N_t^x(i, h)$ is the quantity of type- h labor employed by firm i in sector x in period t . The parameter σ_w represents the elasticity of substitution among labor varieties. The demand schedule for each labor type is obtained by cost minimization

$$N_t^x(i, h) = \left(\frac{W_t(h)}{W_t} \right)^{-\sigma_w} N_t^x(i), x = N, T \quad (16)$$

for all $i, h \in [0, 1]$, where $W_t(h)$ is the nominal wage for type h labor, $W_t = \left[\int_0^1 W_t(h)^{1-\sigma_w} dh \right]^{\frac{1}{1-\sigma_w}}$ is an aggregate wage index and N_t^x is firm's total employment. All firms face an isoelastic demand schedule (specified below). Finally each firm may reset its price with probability $1 - \vartheta_p$ in any

given period independently of the time elapsed since the last adjustment. Firms must pay a social contribution in the form of a proportional tax, $\tau_{w,t}$, on their wage bill.

Households

Assume a continuum of households indexed by $h \in [0, 1]$. The household seeks to maximize

$$E_t \left\{ \sum_{s=t}^{\infty} U(C_{t+s}(h), N_{t+s}(h)) \right\} \quad (17)$$

where $N_t(h)$ is the quantity of labor supplied. Each household is assumed to specialize in the supply of a different type of labor, also indexed by $h \in [0, 1]$. Furthermore, each household has some monopoly power in the labor market, and posts the (nominal) wage at which it is willing to supply specialized labor services to firms that demand them. Assume that for each period only a fraction $1 - \vartheta_w$ of household, drawn randomly from the population, reoptimize their posted nominal wage. Under the assumption of full consumption risk sharing across households, all households resetting their wage in any given period will choose the same wage, because they face an identical problem. $C_t(h)$ is a composite consumption index

$$C_t(h) = \left[(1 - \gamma)^{\frac{1}{s}} (C_t^N(h))^{\frac{s-1}{s}} + \gamma^{\frac{1}{s}} (C_t^T(h))^{\frac{s-1}{s}} \right]^{\frac{s}{s-1}} \quad (18)$$

where $C_t^N(h)$ is an index of consumption of domestic non traded goods

given by a constant substitution elasticity aggregator

$$C_t^N(h) = \left[\left(\frac{1}{n} \right)^{\frac{1}{\sigma_n}} \int_0^n (c_t^N(h, i))^{\frac{\sigma_n-1}{\sigma}} di \right]^{\frac{\sigma_n}{\sigma_n-1}} \quad (19)$$

where $c_t^N(h, i)$ denotes the consumption by household h of good $i \in [0, 1]$ denotes the good variety, $n \in [0, 1]$ denotes the size of the domestic economy (which corresponds to the type of goods it produces) and $\sigma_n > 1$ the elasticity of substitutions between goods. In equation 18, the parameter s denotes the elasticity of substitution between non traded and traded goods, γ denotes the share of consumption allocate to traded goods and $C_t^T(h)$ is a composite index of consumption of traded goods

$$C_t^T(h) = \left[\nu^{\frac{1}{\lambda}} (C_t^H(h))^{\frac{\lambda-1}{\lambda}} + (1 - \nu)^{\frac{1}{\lambda}} (C_t^F(h))^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}} \quad (20)$$

where $C_t^H(h)$ and $C_t^F(h)$ are respectively an index of consumption of domestic goods and foreign goods given by a constant elasticity of substitution aggregator

$$C_t^H(h) = \left[\left(\frac{1}{n} \right)^{\frac{1}{\sigma_n}} \int_0^n (c_t^H(h, i))^{\frac{\sigma_n-1}{\sigma}} di \right]^{\frac{\sigma_n}{\sigma_n-1}} \quad (21)$$

$$C_t^F(h) = \left[\left(\frac{1}{1-n} \right)^{\frac{1}{\sigma_n}} \int_n^1 (c_t^F(h, i))^{\frac{\sigma_n-1}{\sigma}} di \right]^{\frac{\sigma_n}{\sigma_n-1}} \quad (22)$$

In equation 20 $\nu = 1 - (1 - n)\alpha$ where $\alpha \in [0, 1]$ denotes the degree of openness. The parameter $\sigma_n > 1$ denotes the elasticity of substitution between domestic goods. Maximization of 17 is subject to a sequence of budget

constraints of the form

$$\begin{aligned}
& (1 + \tau_{c,t}) \left(\int_0^n p_t^H(i) c_t^H(h, i) di + \int_0^n p_t^N(i) c_t^N(h, i) di + \int_n^1 p_t^F(i) c_t^F(h, i) di \right) \\
& + B_{t+1}(h) + E_t \{ Q_{t,t+1} D_{t+1}(h) \} + M_{t+1}(h) \leq R_t B_t(h) + D_t(h) + M_t(h) + W_t(h) N_t(h) + \Pi_t(h) + T_t(h)
\end{aligned} \tag{23}$$

where $\tau_{c,t}$ is a proportional tax on consumption, $p_t^x(i)$, $x = H, N, F$ are the individual prices of each good, D_{t+1} is the nominal payoff in period $t+1$ of the portfolio of financial assets held at the end of period t (domestic financial markets are complete to simplify the introduction of nominal wage rigidities which requires insurance between workers to avoid income heterogeneity and the departure from the representative agent), B_{t+1} is a nominal riskless bond, M_{t+1} is the quantity of money, R_t is the nominal gross interest rate on the nominal bond, W_t is the nominal wage, Π_t are the profits of the firms and T_t denotes lump-sum transfers/taxes. $Q_{t,t+1}$ is the stochastic discount factor for one-period-ahead nominal payoffs relevant to the domestic household. The optimal allocation of any given expenditure within each category of goods yields the demand functions

$$c_t^H(h, i) = \frac{1}{n} \left(\frac{p_t^H(i)}{P_t^H} \right)^{-\sigma_n} C_t^H(h) \tag{24}$$

$$c_t^N(h, i) = \frac{1}{n} \left(\frac{p_t^N(i)}{P_t^N} \right)^{-\sigma_n} C_t^N(h) \tag{25}$$

$$c_t^F(h, i) = \frac{1}{1-n} \left(\frac{p_t^F(i)}{P_t^F} \right)^{-\sigma_n} C_t^F(h) \tag{26}$$

for all $h, i \in [0, 1]$, $P_t^H = \left[\frac{1}{n} \int_0^n (p_t^H(i))^{1-\sigma_n} di \right]^{\frac{1}{1-\sigma_n}}$, $P_t^N = \left[\frac{1}{n} \int_0^n (p_t^N(i))^{1-\sigma_n} di \right]^{\frac{1}{1-\sigma_n}}$ and $P_t^F = \left[\frac{1}{1-n} \int_n^1 (p_t^F(i))^{1-\sigma_n} di \right]^{\frac{1}{1-\sigma_n}}$ are the price indexes for each category of good. The optimal allocation of expenditure in tradable goods between domestic and foreign implies

$$C_t^H = \nu \left(\frac{P_t^T}{P_t^H} \right)^\lambda C_t^T \quad (27)$$

$$C_t^F = (1 - \nu) \left(\frac{P_t^T}{P_t^F} \right)^\lambda C_t^T \quad (28)$$

where $P^T = \left[\nu (P_t^H)^{1-\lambda} + (1 - \nu) (P_t^F)^{1-\lambda} \right]^{\frac{1}{1-\lambda}}$ is a price index of tradable goods. Finally the optimal allocation of expenditure between tradables and non tradables is given by

$$C_t^N = \left(\frac{P_t}{P_t^N} \right)^s (1 - \gamma) C_t \quad (29)$$

$$C_t^T = \left(\frac{P_t}{P_t^T} \right)^s \gamma C_t \quad (30)$$

where $P = \left[(1 - \gamma) (P_t^N)^{1-s} + \gamma (P_t^T)^{1-s} \right]^{\frac{1}{1-s}}$ is the consumer price index (CPI).

Intertemporal conditions

A firm reoptimizing in period t will choose the price $p_t^*(i)$ (I have omitted the superscript of the sector) that maximizes the current market value of the profits generated while that price remains effective. The first-order condition

associated with the problem above takes the form

$$\sum_{k=0}^{\infty} (\vartheta_p)^k E_t \{Q_{t,t+k} Y_{t+k}(i) (p_t^*(i) - \mu_p \psi_{t+k}(i))\} = 0 \quad (31)$$

where $\psi_{t+k}(i) \equiv \frac{(1+\tau_t^W)W_t}{(1-\alpha)A_t N_t(i)^{-\alpha}}$ is the nominal marginal cost and $\mu_p \equiv \frac{\sigma}{\sigma-1}$ is the desired firm's markup in absence of nominal rigidities. A household resetting its wage $W_t^*(h)$ in period t , maximize its utility while the wage remains effective. The first order condition associated with the problem above takes the form

$$\sum_{k=0}^{\infty} (\beta \vartheta_w)^k E_t \left\{ N_{t+k}(h) U_c(C_{t+k}(h), N_{t+k}(h)) \left(\frac{W_t^*(h)}{P_{t+k}} - \mu_w MRS_{t+k}(h) \right) \right\} = 0 \quad (32)$$

where $MRS_t(h) \equiv -\frac{(1+\tau_{c,t})U_n(C_t(h), N_t(h))}{U_c(C_t(h), N_t(h))}$ is the marginal rate of substitution between consumption and work and $\mu_w \equiv \frac{\sigma_w}{\sigma_w-1}$ is the desired worker's markup in absence of nominal rigidities. In addition to the wage setting condition, the household's problem also yields a conventional set of Euler equations

$$U_c(C_t(h), N_t(h)) = \beta E_t \left[Q_{t,t+1}^{-1} \frac{1 + \tau_{c,t}}{1 + \tau_{c,t+1}} \frac{P_t}{P_{t+1}} U_c(C_{t+1}(h), N_{t+1}(h)) \right] \quad (33)$$

$$E_t \{Q_{t,t+1}\} = \frac{1}{R_t} \quad (34)$$

International prices

I assume the law of one price for tradables

$$P_t^F(i) = P_t^{F*}(i); P_t^H(i) = P_t^{H*}(i)$$

The real exchange rate

$$Q_t = \frac{P_t^*}{P_t}$$

and the terms of trade

$$S_t = \frac{P_t^F}{P_t^H}$$

Aggregate conditions

Given the assumed wage setting structure, the evolution of the aggregate wage index is given by

$$W_t = \left[\vartheta_w W_{t-1}^{1-\sigma_w} + (1 - \vartheta_w)(W_t^*)^{1-\sigma_w} \right]^{\frac{1}{1-\sigma_w}}$$

while the assumed price setting structure implies

$$P_t = \left[\vartheta_p P_{t-1}^{1-\sigma_p} + (1 - \vartheta_p)(P_t^*)^{1-\sigma_p} \right]^{\frac{1}{1-\sigma_p}}$$

Market clearing in the nontradables goods market requires

$$Y_t^N(i) = C_t^N(i) = \int_0^1 c_t^N(h, i) dh$$

for all $i \in [0, 1]$ and all t . Market clearing in the tradables goods market

requires

$$Y_t^H(i) = C_t^H(i) + C_t^{H*}(i) = \int_0^1 c_t^H(h, i)dh + \int_0^1 c_t^{H*}(h, i)dh$$

Letting aggregate output in each sector be defined as $Y_t^x \equiv \left(\int_0^n Y_t^x(i)^{\frac{\sigma_p-1}{\sigma_p}} di \right)^{\frac{\sigma_p}{\sigma_p-1}}$ it follows that $Y_t^N = C_t^N$ and $Y^H = \left[\nu \left(\frac{P_t^T}{P_t^H} \right)^\lambda \left(\frac{P_t}{P_t^T} \right)^s \gamma C_t + \frac{1-n}{n} \nu^* \left(\frac{P_t^{T*}}{P_t^{H*}} \right)^\lambda \left(\frac{P_t^*}{P_t^{T*}} \right)^s \gamma C_t^* \right]$ holds for all t .

Market clearing in the labor market requires

$$N_t = \int_0^n \int_0^1 N_t^N(h, i)dhdi + \int_0^n \int_0^1 N_t^H(h, i)dhdi$$

The foreign country (rest of the union) is represented by a symmetric set of equations.

Fiscal Policy

The fiscal authority is assumed to rebate tax income to households

$$\tau_{c,t}C_t + \tau_{w,t}W_tN_t = T_t = \int_0^1 T_t(h)dh$$

Monetary policy

The central bank runs a common monetary policy for the two countries, responding only to aggregate union-wide variables (U) that is represented by a Taylor Rule

$$R_t = \bar{R} \left(\frac{P_t^U}{P_{t-1}^U} \right)^{\phi_p} \exp(\epsilon_t^m)$$

where ϕ_p denotes the feedback coefficient associated with the union wide inflation gap (where the target is assumed to be zero) and ϵ_t^m is an iid monetary policy shock.

Utility is assumed to have the following functional form

$$U_t = \frac{C_t^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \chi \frac{N_t^{1+\phi}}{1+\phi}$$

The small open economy

The small open economy is derived taking the $\lim_{n \rightarrow 0}$. The advantage of the limit economy is to shut down all strategic interactions and allow to consider Foreign (rest of the monetary union) variables as exogenous. The cost of the limit economy is that with incomplete asset markets the steady-state that depends on initial conditions (the initial net asset position) and the equilibrium dynamics possess a random walk component. The assumption of net foreign debt elastic interest rate allows to close the model.

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